But the embryo plant, wrapped in its seed or spore, more easily overcomes these obstacles. Before it becomes a rooted organism it has a greater freedom.

This idea may be enforced by quoting a few sentences from a work already referred to, that of Hildebrand: "It might seem that animals, in their ability to move freely over the surface of the earth, had a great advantage over plants in their dissemination. But plants find a compensation that more than offsets their lack of free movement. It consists in the fact that their descendants, before striking root in the ground, can, by means of various contrivances, be spread around the parent plant in a wide circle, and reach a place to which an animal can scarely attain, notwithstanding its ability to move freely. There are a great many obstacles which cannot be overcome by an animal that walks or flies. It is not able to pass over a chain of mountains of a certain height, or cross a broad expanse of water by swimming or flying. If permitted by its organization to live only in a marsh, it cannot wander from one marsh to another, or far away from the marsh in which it lives. 'No more can an animal, whose home is in the forest, master the difficulties of broad, treeless plains. But all these hindrances are more or less easily overcome by the seeds of plants. Being provided in themselves or their surroundings with the most varied equipments, they are borne far away by wind and water; and even in spreading obtain aid from the freedom of movement of animals, by whom they may be carried to distant places."[1]

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IS THE GROUP ARTHROPODA A VALID ONE?

BY J. S. KINGSLEY.

SEVERAL years have passed since the four sub-kingdoms of Cuvier—radiates, mollusks, articulates and vertebrates—fell, more or less, into disuse, and now in their places we find a number of groups, varying according to the author followed. But by all the group Arthropoda is accepted, only a very few, in print, expressing any doubts as to its validity. The question of its naturalness we here propose to discuss in a very brief manner.

According to the old canons of classification, comparative anatomy was made the basis of systematic arrangement, and

[1] Die Verbreitungsmittel der Pflanzen, pp. 1, 2.

those animals which in their adult state possessed certain features in common were grouped together; but with the study of embryology and the introduction of the principles of evolution, this is gradually being set aside and only those forms are associated which are shown to have had a common ancestry and a common descent. Thus classification will eventually be founded on genetic relationships, and not primarily on analogies of structure and accidents of form produced by similarity of environment and similar causes without a common ancestry.

At first sight the homologies between the two groups of Arthropoda, Crustacea and Tracheata, seem very evident and easy to trace, the two groups appearing to be closely related. We find in each the same general features, a jointed body, each segment of which is, to a certain extent, a repetition of its immediate neighbors. To this jointed body are attached a varying number of jointed appendages each modified for the purpose of feeding, locomotion or reproduction. A straight alimentary canal traverses the body as an axis, and above it is found the dorsal vessel or functional heart, while on the floor of the body cavity is found the nervous cord, consisting of a series of ganglia connected by commissures, and in each group, when the œsophagus is reached, a commissure passes on either side connecting the ventral chain with the brain or supra-œsophageal ganglion.

Thus far our knowledge, derived from comparative anatomy, seems conclusive, but when we attempt to trace homologies farther, we become entangled in a snarl which we think cannot be untangled except by heroic treatment.

In the Crustacea the eyes, two pairs of antennæ and the simple median eyes of the young of many forms are innervated from the supra-œsophageal ganglion; in insects one pair of antennæ are entirely absent, and we have nothing to indicate whether the pair which exists corresponds to the antennæ or to the antennulæ of the Crustacean. In the insect the post-oral appendages of the head are three, mandibles, maxilla and labium; in the Crustacean we find the same number of cephalic appendages, mandibles, first and second maxillæ, but beyond this we cannot carry our homology in a serial order. And further, the appendages themselves in the two groups show very marked and important differences. In the Crustacea the typical structure is biramous; we have a basal joint bearing two jointed branches. These parts to be sure are not

evident in the adult of all forms, but they are almost invariably found in the young at some stage of development.[1] In insects the biramous structure of limb is never found,[2] the appendages in all Tracheata having a simple form consisting of a number of joints serially arranged. In the Crustacea the organs of respiration, when present, are either limbs modified for aerating the blood or are appendages borne on the limbs.[3] In the insects, when the respiratory organs are present, we find air-tubes or tracheæ permeating all parts of the body. In some forms no specialized organs for breathing are found, while in the higher Arachnida pulmonary sacs are found in addition to the tracheal system. To repeat, in the Crustacea the blood is brought to the oxygen, in the insect the air is carried to the blood.

When we turn to the alimentary tract we find an equally marked contrast between the two. In the Crustacea the primitive stomach (archenteron) is usually formed by an invagination, while in the insects this is never, so far as our present knowledge extends, the case. The various portions of the alimentary tract of the two groups are equally difficult to homologize; in fact, any attempts in this direction result in showing analogies rather than homologies, if we except the three grand divisions of proctodæum, stomodæum and mesenteron, common to all the higher Metazoa, and these divisions in their method of origin show as wide differences in the insects and in the Crustacea as they do in any two portions of the animal kingdom. In the Crustacea we find a more or less developed liver, while among the insects such an organ is not well differentiated, and on the other hand the salivary glands and malpighian vessels of the Tracheata are without parallel in the Crustacea.

In their development the Crustacea and Insecta show most markedly their diverse characters. The segmentation of each, as a rule, centrolecithal, but the importance of this similarity can be estimated when we reflect that in *Gammarus locusta* we have a total segmentation, while in the closely allied *G. pulex* it is partial. From this point on every stage of development shows

[1] As will be seen farther on the writer does not consider Limulus a Crustacean.

[2] With the solitary exceptions of Pauropus and Eurypauropus Ryder, where a biflagellate antenna is found, but which can hardly be regarded as invalidating the rule.

[3] The "lung" of Birgus and some of the land crabs is a secondary and adaptive feature, and has no importance in this connection.

diverging features, which, as they are well known, need not be repeated here. The whole course of development shows that the insects have been derived from a form like Peripatus, while the Crustacea have had an ancestor resembling the Nauplius of the Phyllopoda or the Copepoda. In both the insects and the Crustacea we have in the larval and in the adult state a serially segmented body with appendages on the metameres, but this merely points to a common Annelidan ancestor, and with the exception of the Mollusca is a feature common to almost all animals above the Cœlenterata. The ecdysis which occurs in the Arthropoda is not to be regarded as indicating close relationship, but rather as an adaptive feature, resulting from the unyielding character of the hardened integument. In short, the only point not to be easily explained, if we regard the two groups as not nearly related, is the compound eye common to both, and which occurs nowhere else in the animal kingdom. Still we have only to consider the close resemblance of the eyes of the vertebrates and of the dibranchiate Cephalopoda to see how little weight one organ can have in classification.

In the foregoing discussion, which is merely suggestive and by no means exhaustive, no attention has been paid to the Tardigrada, Pycnogonids, Limulus and Linguatulina. It may be that they will have to be elevated to groups each equivalent to the insects and Crustacea, or, as has been argued, that they are branches from the Arachnida. We do not at present know enough concerning the embryology of these groups to settle these points, but the little which we do know, when considered in connection with our anatomical data, is sufficient to show that none of them belong to the Crustacean Phylum.

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THE SERPENTINE OF STATEN ISLAND, NEW YORK.[1]

BY T. STERRY HUNT, LL.D., F.R.S.

THE serpentine of Staten island appears as a north and south range of bold hills rising out of a plain of Mesozoic rocks. On the west side are Triassic sandstones like those of the adjacent mainland, including a belt of intrusive diabase, and on the east the overlying and nearly horizontal Cretaceous marls, which are traced south and west into New Jersey. The only rocks be-

[1] Read at Minneapolis meeting of A. A. A. S., Aug. 21, 1883.